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पैकेजबन्दी के लिए आसंजकों के उपयोग की रीति संहिता

(पहला पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR USE OF ADHESIVES FOR PACKAGING

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

CODE OF PRACTICE FOR USE OF ADHESIVES FOR PACKAGING

(First Revision)

1 SCOPE

1.1 This standard prescribes a code of practice for use of adhesives in the manufacture of packaging materials and sealing packages. Each type of adhesive is classified by source, principal characteristics and application followed by more extensive information on properties, typical application and health and safety consideration.

2 REFERENCES

2.1 The Indian Standards relating to adhesives that may be of relevance to packaging have been given in Annex A.

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 3434 : 1984 shall apply.

4 TYPES

4.1 Adhesives may be broadly divided into following groups:

a) Bituminous (*see* **7**);

b) Inorganic (*see* **8**);

c) Rubber based — natural and synthetic (*see* **9**);

d) Protein (*see* **10**);

e) Synthetic polymers and resins — melts, solutions and dispersions (*see* **11**);

f) Thermoplastic adhesives [supplied in solid form (*see* **12**)];

g) Vegetable — starches and dextrins — resins and gums (*see* **13**); and

h) Miscellaneous (*see* **14**).

4.1.1 The characteristics of these types differ in many respects but each has its field of use for packaging purposes.

5 CHOICE OF ADHESIVE

5.1 Selection

5.1.1 The choice and application of the correct adhesive for a particular purpose are of the utmost importance and selection should be made only after due consideration of technical advice.

5.1.2 It is not practicable in a code of this kind to make detailed recommendations as to the best adhesives for a particular end use. In selecting an adhesive the following factors shall be considered:

a) Whether the resulting joint will be sufficiently strong for the required purpose and under the conditions of storage;

b) The technique of application to be employed;

c) Convenience and economy in use; and

d) The possible long term interaction of the adhesive with other components of the completed pack, for example, effect on inks, corrosive effect, effect of plasticiser migration, etc.

Wherever possible, the selection should be checked by practical tests including field trials where appropriate.

5.2 Classification

5.2.1 Table 1 gives a classification of adhesives which may serve as a useful guide in a general way. The various adhesives are more fully discussed in the subsequent clauses.

5.2.2 Annex B lists a number of packaging end uses identifying the most suitable types of adhesives for each, from which the selection could be made in the light of factors given in **5.1.2**.

5.2.3 The use of synthetic adhesives is very wide and constantly being extended, and the manufacturer should always be consulted and full details of requirements should be furnished for any particular problem.

6 PRECAUTIONS IN USE

6.1 Handling and Storage

Special precautions may be necessary when handling or storing certain types of adhesives (for example, because of flammability, toxicity or risk of dermatitis). It is, therefore, recommended that the relevant local authorities and the supplier of the adhesives should be consulted as to any statutory or local regulations or recommendations that may affect handling or storage. It is a good practice to store all liquid adhesives at temperatures between 20°C to 30°C, unless otherwise stated by the supplier.

6.2 Toxicity

Some adhesives contain ingredients, for example, isocyanates, which are toxic and this will

Table 1 Classification of Adhesives

(*Clause* 5.2.1)

Sl No.	Type	Source/Manufacture	Constituents and Principal Characteristics	Typical Applications
(1)	(2)	(3)	(4)	(5)
a)	Bituminous Adhesives			
	i) Asphaltic bitumen	a) Residue from distillation of crude petroleum b) Mineral bitumen	Aliphatic hydrocarbons; black or dark; viscous ranging to solid; sometimes pigmented	For board, paper and metal foil laminations, tube winding, sealing paper packages
	ii) Coal tar and pitch	From destructive distillation of coal;		
		a) High temperature carbonization	Aromatic hydrocarbons; black viscous ranging to solid	
		b) Low temperature carbonization	Brown; viscous ranging to solid: sometimes pigmented General for (i) and (ii) thermoplastic. Normally used hot but can be obtained as an emulsion Good water resistance. Low water vapour transmission rate. Tack, set, bond strength, etc, vary according to viscosity softening point.	
b)	Inorganic adhesives, sodium silicate and mixtures	Solution of sodium silicate in water; wide range of types depending on ratio of silicon dioxide to sodium oxide	Alkaline stable aqueous solution, hard and brittle bond, poor water resistance, good resistance to heat or cold	Paper and board lamination, manufacture of corrugated paper and board, tube winding, fibreboard case sealing
		Silicate mixtures consisting of sodium silicate with the addition of inorganic material such as clay or whiting	Sodium silicate mixtures are similar to sodium silicate but have modified viscosity and quicker setting	
c)	Rubber Based Adhesives (Natural & Synthetic)			
	i) Natural rubber solution	Natural rubber; dispersed in organic solvent, may contain resins, fillers and sometimes vulcanizing agents	Consistencies from moderate to very thick; black, white or transparent; quick drying; usually highly flammable but non-flammable forms are also available; joints water-resistant, flexible and permanent; resistant to moulds and bacteria; by suitable formulation can be made to adhere to all surfaces; surfaces may be pre-cemented and assembled by dry tack or rubber adhesive film	Attachment of rubber cushioning material to wooden bracing or blocking (by hand application) can be used as a self-sealing adhesive, cartons forming
	ii) Natural latex adhesive	The natural latex exuding from the cut bark of the rubber tree ‘*Hevea brasiliensis* consisting of minute particles of rubber hydrocarbon dispersed in water; after preservation, stabilization and concentration it may be used as such, or supplied compounded with resins, gums, thickners and sometimes vulcanizing agents	Water borne dispersion, may or may not contain ammonia non-flammable, versatile adhesive consistencies range from thin mobile fluid to highly viscous paste; deposits films having dry tack or may be used by wet stick method slower drying; gives strong flexible water resistant joints with improved adhesion	Suitable for machine applications can-sealing compounds. Can be used as self-sealing adhesive Gold seal coatings, labelling of plastic containers, carton forming

Table 1 (*Continued*)

Sl No.	Type	Source/Manufacture	Constituents and Principal Characteristics	Typical Applications
1	2	3	4	5
iii)	Synthetic rubber solutions	Polychloroprene polymers or butadiene acrylonitrile copolymers or styrenebutadiene copolymers (SBR) dissolved in organic solvents, usually esters, ketones or hydrocarbons; usually supplied compounded with vinyl or phenolic resins	The SBR solutions in hydrocarbon are fast drying adhesives very similar to natural rubber solutions; they are more resistant to oxidation but less tough and resilient and equally susceptible to attack by oils and petrol The polychloroprene and nitrile rubber solutions in ketone and ester solvents are highly flamable; give very tough, hard and permanent but flexible bonds; are resistant to petrol, oil and water	For joining flexible materials, rubber, fabrics, paper and plastics or regenerated cellulose film excluding untreated polyolefines or other difficult surfaces also as for natural rubber solutions but where specially stable resistant joints are required
iv)	Synthetic rubber latex adhesives	Polychloroprene, butadiene acrylonitrile and SBR copolymer-lattices are formed by polymerizing emulsions of the corresponding monomers Nitrile and SBR lattices contain antioxidants and stabilizers; vulcanizing agents may be included in compounded nitrile or SBR latex adhesives but polychloroprene latex is fully pre-cured all need compounding with resin emulsions to produce dry tack or heat-activatable bonds	Non-flammable; consistencies range from thin mobile fluid to highly viscous paste; deposits films having limited dry tack and generally used by wet stick method Reactless to copper and brass than natural rubber lattices. Possessed of specific adhesion to a wider range of nonporous substrates than natural lattices Less suitable for assembly by dry tack than natural rubber	For the bonding of certain laminated and coated paper and board surfaces
d)	Protein Adhesives			
i)	Animal glues from hide or bone	Made by acid, nautral or alkaline hydrolysis of hide or bone. Normally defoamed for packaging applications	Available in powder or jelly form. Gives immediate tack. Normally used in warm aqueous solution; sets reversibly on cooling to a gel which forms a temporary bond, strengthening as it dries further. Near neutral *p*H. Poor water resistance.	Wood glueing, tube-winding, paperboard container making and gummed tape manufacture
ii)	Compounded animal glues	Made by compounding animal glues with plasticizers, humectants, gel depressants tanning agents, etc	Available in powder, jelly, or liquid form. Improvement of original animal glue characteristics for specific purposes, for example, non-warp glues for box-covering	As above
iii)	Fish glues	Made by hydrolysis of fish wastes	Liquid form, similar to animal glue but does not gel and can be used as a cold solution which forms a bond on drying. Poor water resistance	Paperboard container making. Added to other adhesives to give improved wet tack
iv)	Casein adhesives	Manufactured from milk by acid precipitation and then formulated with alkali and other solubilizing agents	Aqueous solution, good water resistance but is soluble in mild alkali	Hot and cold press wood glueing. Also obtainable compounded with latex emulsion for foil and paper laminating, bottle and can labelling, bag seaming, etc

Table 1 (*Continued*)

Sl No.	Type	Source/Manufacture	Constituents and Principal Characteristics	Typical Applications
1	2	3	4	5
e) Synthetic Resin Adhesives				
	i) Thermosetting resins			
	1) Phenol formaldehyde	Reaction of phenols with formaldehyde under controlled conditions	Generally supplied dispersed in water or water/methylated spirit mixture, but sometimes in other solvent. Various types cure at room temperature or under heat, some need catalyst and some need heat only. Gap filling. Resorcinol glues cure cold under neutral conditions; phenol glues cure cold under acid conditions only. Dark coloured. Available in film form using paper as carrier. Good water resistance	Wood assembly operations
	2) Urea/melamine formaldehyde	Reaction of urea/melamine with formaldehyde under controlled conditions	Liquid or powder form. Used with catalysts which are either mixed in giving limited pot life, or may be applied separately. Not naturally gap filling, but such grades are available. Colourless, curing hot or cold under acid conditions.	Wood glueing, manufacture of wood chip-board, wet strength papers, improving water resistance of starch and dextrin adhesives. Melamine formaldehyde is used to improve durability of urea-formaldehyde glues
	3) Epoxy resins	Synthetic resins containing epoxy groups available for cross linking, with suitable hardness. May be formulated to include solvents and fillers	Available as liquids, pastes or solids and in one-part or two-part system. Excellent strength in shear with a wide variety of surfaces	Special application for difficult surfaces sealing of metal containers
	4) Polyurethanes	Resins containing hydroxyl groups reacted with isocyanates	In general two-part adhesives in organic solvents. Good heat, water and solvent resistance, and good clarity after curing	Film lamination
	ii) Thermoplastic resins applied in solution or emulsion form			
	1) Polyvinyl acetate homopolymers and copolymers	Polymers manufactured by homopolymerization of vinyl acetate or its copolymerization with other monomers. They may be compounded with plasticizers and viscosity adjusters	Available in solution in organic solvents giving clear, tacky solutions. Available in emulsions of very wide range of formulae. Gives normally colourless films varying from tough and resilient to very soft and flexible. Good adhesion to paper and wood. Limited water resistance.	Paperboard container making and sealing, gluelap and case sealing, tubewinding, paper and board laminating cellulose film conversion. Heat-seal adhesives. Harder grades used as wood glues. Remoistenable adhesive copolymers in addition gives adhesion to more difficult surfaces such as some plastics or lacquered surfaces Palletizing adhesive or alkali dispersible grades are available.
	2) Other vinyl resins	Polymerization of other vinyl monomers, for example, vinyl esters, vinyl chloride, ethylene/vinyl acetate	Available in solid, solution or emulsion forms. Films deposited can vary from hard to soft and permanently tacky	Heat-seal adhesives and a wide variety of specialist converting operations, for example, blister and skin packaging

Table 1 (*Continued*)

Sl No.	Type	Source/Manufacture	Constituents and Principal Characteristics	Typical Applications
1	2	3	4	5
	3) Polyvinyl alcohol	Made by hydrolysis of polyvinyl acetate	The degree of water resistance depends on the formulation. Powder or aqueous solution. Flexible oil-resistant	Paper adhesive, remoistenable label and envelope adhesive. Board lamination
	4) Acrylic resins	Homo and copolymer mainly of acrylate esters	Available in solution and emulsion forms; have properties similar to PVA emulsions. Give better adhesion than PVA to many surfaces. Films vary from relatively hard to soft and tacky. Some grades can be cross-linked by heat with or without catalyst. Good ageing characteristics	Plastic films conversion, self adhesive tapes and labels. Lamination of unsupported film to timber
	iii) Thermoplastic resins supplied in solid form			
	1) Hot melt	These normally contain the following major components: i) Polymers of ethylene/vinyl acetate, ethylene/vinyl acrylate, polyamides, polypropylene, etc ii) Wax or waxes iii) Resins	Available in solid form applied molten to give flexible adhesive films and coatings with good barrier properties. By suitable formulation, products can vary in open time from less than 1 s to types which remain fully tacky (pressure-sensitive). Will bond porous and non-porous substrates	Pressure-sensitive (self-adhesive tapes). High speed carton and case sealing. Heat seal and pressure sensitive coatings. High speed container labelling. Lamination of porous and non-porous packaging substrates. Palletizing adhesive
	2) Microcrystalline waxes	Obtained from certain types of heavy lubricating oils, distillates or residues. They may be modified with various resin derivatives and fillers	Available in solid form; applied molten. Good water vapour and water resistance. Good grease barrier. The modified types have improved flexibility and may be used on more porous substrates	Lamination of board, paper glossines, parchments, metal foils, regenerated cellulose and some plastic films
f)	Vegetable Adhesives			
	i) Flour and unmodified starch pastes	Flour or starch made up in water	Solids concentration normally 5 to 25 percent. Poor water resistance, slow drying, low tack. Varying from thick to soft buttery consistency	Paper bag making. Hand labelling, overlap labelling of cans
	ii) Modified starches	Starches modified by various processes	Solids concentration up to 40 percent. Varying from rubbery, cohesive jelly gum to fluid solutions. Generally alkaline. Fair water resistance, can be improved by addition of synthetic resins	Bottle labelling. Foil/paper lamination
	iii) Dextrins	a) Dextrin glues — Alkaline treated dextrin dissolved in water	Normally alkaline of 30 to 50 percent solid concentration. Poor water resistance. Quicker tack and set than starch adhesives	Board lining. Paperboard container and case sealing. Tube winding, etc
		b) Dextrin gums — Essentially dextrin dissolved in water	Usually high solid concentration 50 to 70 percent, *p*H normally acidic unless specially adjusted. Poor water resistance. Quicker tack and set than starch adhesives	Bottle labelling. Packet sealing. Envelope manufacture

Table 1 (*Conculded*)

Sl No.	Type	Source/Manufacture	Constituents and Principal Characteristics	Typical Applications
1	2	3	4	5
iv)	Natural gums and natural resins	a) Water soluble — for example, gum arabic	Tacky, fast drying, Readily remoistenable. Poor water resistance	Gummed paper labels and tapes. High quality office paste
		b) Spirit soluble	Good water resistance	Dry-mounting, labelling can-seam dopes (hot pick-up)
		1) Wood rosin and chemically derived synthetic resin based on rosin available in solution emulsion or solid form		
		2) Shellac (Insect exudates)		Adhesion promoter for printing on aluminium foil
v)	Cellulose derivatives	a) Water soluble — for example, carboxy methylcellulose	Powder or solution. Similar bonding properties to starch pastes	Paper and paperboard industry. Thickener and modifiers in other adhesives
		b) Spirit soluble — for example, cellulose nitrate (nitrocellulose)	Low solid/high viscosity solutions. Compatible with most resins	Heat-sealing coatings, Heat-sealing lacquers
g)	Miscellaneous Adhesives Mixtures			
i)	Emulsion starch	Polyvinyl acetate and starch mixture	High viscosity pasty adhesives which are faster setting than starch pastes and provide better adhesion	Overlap labelling of cans
ii)	Casein latex	Casein solution and natural or synthetic rubber latex mixture	Modification of latex properties to give improved adhesion of the dried film. Can be formulated to provide improved solubility in alkali	Lamination of aluminium foil to paper and board. Self-seal trays and envelopes. Plastics bottle labelling
iii)	Vinyl dextrin	Dextrin is added during the polymerization of vinyl acetate. Compounded with humectants, viscosity adjusters and preservatives, etc	Combines the good remoistenable tack of dextrine adhesives and the non-curing properties of emulsion adhesives	Envelope front seal adhesives. Bottle labelling

have to be borne in mind particularly in the choice of adhesives for packaging foodstuffs. In all such cases guidance from the manufacturers shall be obtained on these points.

7 BITUMINOUS ADHESIVES

7.1 General

Bituminous adhesives for packaging purposes may be supplied in solid form to be melted by the application of heat for use, or as a liquid emulsion.

7.2 Properties

7.2.1 *Appearance and Form*

Bitumen is a black solid which varies in softness depending on grades. Soft grades give good penetration to paper or board and impart flexibility but the final bond may have a residual tack.

Hard grades give a more rigid bond and impart better high temperature resistance. The choice of grade therefore depends on service requirements. Bitumen is also available in liquid form, most commonly as an emulsion.

7.2.2 *Viscosity*

The temperature required to melt solid bitumen to the required application viscosity varies with grade, harder grades requiring higher temperatures. Emulsions are available in a range of viscosities and can generally be further diluted with water as required.

7.2.3 *p*H *Range*

Emulsions are generally alkaline although it is possible to prepare emulsions ranging in *p*H from 4 to 11.

7.2.4 *Storage Conditions and Shelf Life*

Materials for use hot, have a shelf life of at least 12 months. Emulsions have a shelf life of at least 3 months but should be protected from frost.

7.2.5 *Bonding Characteristics*

Solid bitumen develops adhesive strength by solidifying between surfaces which have been combined whilst the molten bitumen is liquid enough for wetting of both surfaces. The emulsions depend on loss of water for setting.

7.2.5.1 Resistance to water is good but bitumen bonds are not resistant to solvents and oils, particularly hydrocarbons and chlorinated hydrocarbons. Bonds may become brittle at low temperatures and softer at high temperatures but formulations may be varied to counteract these tendencies.

7.3 Use

7.3.1 *Preparation and Method of Application*

Solid bitumen has to be melted by the action of heat prior to application, typically by roller. Emulsions are normally supplied ready for use either by brush or by machine, but may be further diluted as required.

7.3.2 *End Use*

Production of kraft union (two sheets of unbleached kraft laminated with bitumen) and other paper laminates. Hot applied bitumens are mainly used.

7.3.3 *Health and Safety*

With solid bitumen the main hazards are burns resulting from skin contact with the hot molten adhesive and the inhalation of fumes. To avoid burns, the arms and face should be protected, while the provision of adequate extraction is necessary to avoid inhalation of fumes. Care should be taken not to overheat the adhesive as this could produce a fire hazard. Recommended temperatures for heating should be checked with the supplier.

In emulsion form there are no serious hazards but care should be taken to avoid contact with skin and eyes.

7.3.4 *Restrictions on Use*

Papers laminated with bitumen are not suitable for use in contact or near contact with food because of potential contamination.

8 INORGANIC ADHESIVES (SILICATE ADHESIVES)

8.1 General

Silicate adhesives for packaging purposes are normally solutions of sodium silicate and water.

8.2 Properties

8.2.1 *Appearance and Form*

A clear, naturally colourless solution unless filled.

8.2.2 *Viscosity*

Viscosity properties can be varied to suit hand or machine application. The solid content ranges from 25 percent to 45 percent.

8.2.3 *pH Range*

Only the narrow range of grades termed 'neutral' are used for packaging purposes but these are still alkaline (*p*H 10).

8.2.4 *Storage Conditions and Shelf Life*

Storage conditions are not critical. Silicate adhesives keep indefinitely if not exposed to the atmosphere. Being mineral in origin they are immune from bacterial activity.

8.2.5 *Bonding Characteristics*

Slow setting by the evaporation of water. Silicate bonds have poor resistance to water; and damp conditions may disrupt the bond, but resistance to heat is good. Silicate bonds are brittle and can have sharp edges.

8.3 Use

8.3.1 *Preparation and Method of Application*

Normally supplied in solution form ready for use. Usually applied cold either by hand or machine.

8.3.2 *End Use*

Laminating of paper and board, tube winding and, although in decline, sealing of fibreboard cases.

8.3.3 *Health and Safety*

Silicate solutions are strongly alkaline and therefore irritant. Precautions should be observed in use to prevent contact with the skin and in particular the eyes.

9 RUBBER BASED ADHESIVES (NATURAL AND SYNTHETIC)

9.1 Natural Latex Adhesives

9.1.1 *General*

Natural latex adhesives are emulsions or suspensions of very fine particles of natural rubber in water. For particular purposes natural latex may be compounded with resins, gums or vulcanizing agents.

9.1.2 *Properties*

9.1.2.1 *Appearance and form*

Natural latex adhesives are available in liquid form only. They are normally creamy white in colour and many of them smell strongly of ammonia.

9.1.2.2 *Viscosity*

Natural latex adhesives are prepared in a controlled viscosity which may be kept within close limits. This viscosity can vary from water thin to pasty, depending on the formulation and end use requirement. The solid content typically varies from 35 percent to 60 percent.

9.1.2.3 *p*H *range*

The majority of natural latex adhesives are strongly alkaline, within the *p*H range 9 to 11. Neutral characteristics may be secured, if desired.

9.1.2.4 *Storage conditions and shelf life*

Natural latex adhesives are susceptible to damage by frost and freezing conditions which should therefore be avoided.

The shelf life of these adhesives is normally 3 months to 6 months if the container is adequately sealed and stored between 5°C and 25°C.

9.1.2.5 *Bonding characteristics*

Natural latex adhesives have excellent adhesion versatility and can bond a wide range of boards, varnishes and polymeric films and surfaces. They can be extremely fast setting when adequate pressure is applied.

The dried film is flexible and typically very tough. Natural latex adhesives have good water and heat resistance and some are suitable for autoclaving.

9.1.3 *Use*

9.1.3.1 *Preparation and method of application*

Natural latex adhesives may be applied by brush, spray or machine. Properly compounded latex adhesives are satisfactory for use with roller driven machinery, but regular cleaning with water containing detergent is necessary to remove dried films. It is important that brass be avoided as the copper content has adverse effects on the bond unless special precautions are taken for example chrome plating.

9.1.3.2 *End use*

Natural latex adhesives are used for cold seal coatings and for self-sealing envelopes, cartons and trays. It is essential that pre-coated materials are protected from ultraviolet light and from dust. They should be stored in cool conditions but even when protected in this way the coated material generally has a shelf life of only 6 months. The odour due to the ammonia content necessitates a care with applications for food packaging. Specially compounded natural latex adhesives are used for the labelling of plastics bottles and for carton forming.

9.1.3.3 *Health and safety*

Latex adhesive are non-flammable.

The presence of ammonia may cause inhalent and contact hazards. Avoid skin and eye contact and ensure that adequate ventilation is provided.

9.2 Synthetic Rubber Adhesives

9.2.1 *Properties*

9.2.1.1 *Appearance and form*

Polychloroprene polymers, acrylonitrile copolymers [nitriles or styrenebutadiene copolymers (SBR)] dissolved in organic solvents (usually esters, ketones or hydrocarbons). Also supplied in latex form.

9.2.1.2 *Viscosity*

Synthetic rubber adhesives are prepared to a controlled viscosity, which may be kept within close limits. Solid content may vary from 12 to 70 percent, the higher figure being for latex adhesives.

9.2.1.3 *p*H *range*

The *p*H range between 6 and 10·5.

9.2.1.4 *Storage conditions and shelf life*

Storage temperature should be between 5°C and 25°C. Shelf life can vary widely. Most types will have a shelf life of 6 months to 12 months.

9.2.1.5 *Bonding characteristics*

a) *Dry tack*

Polychloroprene and some SBR adhesives have good dry tack properties. Nitrile adhesives, however, possess very little dry tack.

b) *Drying time*

It is essential to allow the solvent or water to evaporate before making an assembly of non-porous adherends and the drying time needed may vary within wide limits. With porous materials, times may be considerably shortened as the solvents can escape through the pores of the material.

c) *Water resistance*

Synthetic rubber adhesive bonds usually have good water resistance.

d) *Assistance to petrol, mineral oils, vegetable oils and animal oils*

All synthetic rubber adhesives are affected in decreasing order of severity by petrol, and mineral, vegetable and animal oils and fats. SBR adhesives show little or no resistance to oils, while polychloroprenes are affected only by petrol. Nitrile adhesives, particularly if vulcanized, are virtually resistant to all.

9.2.2 *Use*

9.2.2.1 *Preparation and method of application*

Synthetic rubber adhesives may be supplied ready for use for most of the application methods including brushing, spraying, nozzle, roller and curtain coating.

Cleaning of equipment where latex adhesives are used should be carried out before the adhesive has dried, with water containing detergent. Where solvent based adhesives are used, cleaning should be carried out in accordance with the manufacturer's instruction, using the recommended solvent.

Although these adhesives stick to a wide range of adherends, in some cases far stronger bonds can be made by priming certain adherends. The manufacturer's advice should be sought.

9.2.2.2 *End use*

Synthetic rubber adhesives have considerable strength on a very wide range of surfaces, such as wood, metal, cloth, paper, fibre-board, phenolic plastics, rubber and glass. Some plastics, mainly untreated polyolefins, cannot be bonded with these adhesives and certain plastics, such as polystyrene, may be attacked by solvent if present in the adhesive. Some materials such as cellulosic materials, cotton and polyurethane foams can be attacked by hydrochloric acid which may be produced from polychloroprene adhesives. For such materials, specially compounded polychloroprene adhesives are available.

9.2.2.3 *Health and safety*

The solvents used for these adhesives are usually highly flammable and toxic types. Flash point below −2·8°C. Regulations regarding storage, use and disposal of waste material may be followed.

The solvent usually employed are highly flammable and toxic. For SBR adhesives, they are usually petroleum solvents and for polychloroprene adhesives and nitrile adhesives, they are ketone and ester solvents.

Non-flammable chlorinated hydrocarbon solvents are sometimes used, the vapours of which are toxic.

The system of work should be designed to give adequate protection from vapour hazards during the application of solvent based adhesives. This will depend on the circumstances, but may include the provision of adequate ventilation (natural or mechanical) to avoid accumulation of flammable vapours, and use of personal protective equipment to avoid, for example, skin contact.

10 PROTEIN ADHESIVES

10.1 Animal Glues

10.1.1 *General*

Animal glues are made by degradation (hydrolysis) of the proteins in skin and bone, having first removed grease from the later. The hydrolysis is carried out by steam or hot water producing a water soluble material. Because of the variety of raw materials and processes of extraction, animal glue is not a definite compound and various grades are available. There is no sharp delineation between animal glues and technical gelatine, but the later designation is used for the higher grades.

10.1.2 *Properties*

10.1.2.1 *Appearance and form*

Animal glues vary from dark brown to light straw in colour. The glues can be supplied in solid, jelly, or occasionally liquid form. The solid is generally powder of varying grits, but may be of coarser particulate forms, such as diced material, chopped noodles or pearls, and requires dissolving in warm water before use.

10.1.2.2 *Viscosity*

For solid forms, viscosity may be measured at 12·5 percent concentration as a measure of the quality. For grades used in packaging, viscosity would generally range from 0·3 mPa-s 1·3 mPa s (30 mP to 130 mP).

In this test and in testing the more concentrated solutions as used, viscosity determinations are usually carried out at 60°C, though any temperature from 40°C to 70°C may be used, depending on the application temperature of the solution.

A wide range of viscosities is possible and formulations which are too viscous may be diluted with water.

The solid content of such adhesives ready for use ranges from 30 percent to 65 percent.

10.1.2 3 *p*H *range*

The *p*H range will depend on the raw material and the extraction process used. It is normally in the range 5 to 7, but a *p*H below 6 may indicate the presence of sulphur dioxide, which could have a reducing effect on some paper colours.

10.1.2.4 *Storage conditions and shelf life*

Dry animal glues normally have a moisture content of 13 to 16 percent; above this range powders will tend to cake. Hence they should be stored under dry conditions below 25°C and used within 12 months.

Jelly glues and liquid glues should be stored under cool conditions to prevent the jelly melting. It is recommended that they be used within 6 months.

10.1.2.5 *Bonding characteristics*

The dry and jelly glues gel on cooling and this change in physical form gives a very high degree of tack immediately prior to gelling. Although final strength is only achieved by further drying out of water by absorption and evaporation, the initial tack is sufficient in packaging applications to hold the substrates together until final drying is complete.

Liquid animal glues have medium tack, and obtain the greater part of their strength by drying.

Resistance to oils and most solvents is very good. Resistance to heat is good except in some cases where there has been considerable compounding, for example, to give enhanced flexibility. Resistance to cold is good unless one of the substrates is non-porous but resistance to high humidity and water is poor.

Animal glue bonds are subject to microbiological attack unless suitable preservative is incorporated. Jelly glues normally include such preservatives but with dry glue it may be advisable to add a small amount of preservative.

10.1.3 *Use*

10.1.3.1 *Preparation and method of application*

Dry animal glues need to be dissolved in hot water. Glues require soaking in cold water for 1 hour to 3 hour to allow the particles to thoroughly absorb water before raising the temperature to 50°C to 60°C and completing solution.

Jelly glues can be melted immediately and brought to 50°C to 60°C, and may be used neat, or may require dilution depending on formulation and end use.

Glue baths should not be of copper, low carbon steel (mild steel) or cast iron, and should never be heated directly, but always by means of a water bath.

Application may be by means of a brush, a spatula or by a roller coater fitted with a hot bath. It may be desirable in this later case to make up water evaporation by occasional additions. Application equipment can be cleaned after use with warm water.

Animal glues should be used in the temperature range 50°C to 60°C or exceptionally for short periods to 70°C. They should not be allowed to overheat since this causes degradation.

The adhesives may tend to foam in use and although this, when required, is generally controlled by the supplier, difficulties should be brought to the supplier's attention.

10.1.3.2 *End use*

Animal glues can give excellent bonds with wood under dry conditions, but advice should be sought from the suppliers as to the suitability of any particular grade, since grades formulated for other packaging uses may not be satisfactory. For such applications as tube winding, side seaming of cartons and rigid box covering, use is made of the gelling action of the glue to achieve fast production. The grade should be chosen so that gelling occurs as required; if it is too fast, wetting of the substrate will not occur, if too slow, the substrates will not be held together. In the case of rigid box covering it is possible to obtain grades specially formulated to give anti-warp properties.

A coating of animal glue may be revived by moisture and hence it can be used for the manufacture of remoistenable tapes, a medium to low grade generally being used.

10.1.3.3 *Health and safety*

Animal glues are non-flammable and have a good health and safety record. They do contain preservatives, therefore, contact with skin should be avoided. The odour may be somewhat objectionable. Care should be taken to avoid burns from the hot glue.

10.1.3.4 *Jelly strength*

The grade of dry animal glue is often judged by its jelly strength which is a measure of the firmness of the gel obtained at a given concentration under controlled temperature conditions.

10.2 Casein Adhesives

10.2.1 *General*

Casein is the protein in milk and is prepared by precipitation from separated milk. It may be precipitated by rennet or by acids. Only acid caseins are used for adhesive manufacture; to make these adhesives the casein is dissolved in water with the aid of alkalis and peptizing agents.

10.2.2 *Properties*

10.2.2.1 *Appearance and form*

Obtainable as a liquid, generally pale straw to medium yellow in colour, or as a cream coloured fine granular powder.

10.2.2.2 *Viscosity*

Casein adhesives are of medium to high viscosity; use at 20°C to 25°C is often recommended. Where powder is reconstituted in water, viscosity varies from low to gel at room temperature. Solids content may be from 20 percent to 45 percent.

10.2.2.3 *p*H *range*

The *p*H ranges from 6 to 10 depending on formulation.

10.2.2.4 *Storage conditions and shelf life*

Liquid adhesives should be stored at 5°C to 25°C, and shelf life varies with different grades from 3 months to 6 months. End of shelf life is normally shown by a drop in viscosity. Powders should be stored at 5°C to 25°C and shelf life, depending on formulation, may be up to 3 years.

10.2.2.5 *Bonding characteristics*

When applied at the correct temperature and in thin films, tack is very high. The bonding characteristics are sensitive to the adhesive film thickness. Drying is by absorption and evaporation of water but is usually fairly fast.

Resistance to oils and solvents is good as is resistance to heat and cold. Resistance to water may be good, depending on formulation, but it is possible to build in solubility to alkalis.

10.2.3 *Use*

10.2.3.1 *Preparation and application*

Liquid casein adhesives are normally supplied ready for use, but may need warming slightly to give satisfactory application. Application is normally by roller and contact parts should not be of iron or copper. Powders should be mixed with water in the proportions and at the temperature recommended by the manufacturer and are used warm.

11.2.3.2 *End use*

Liquid casein adhesives are used for high speed bottle labelling. They provide water resistance where required but permit removal by washing in mild alkalis.

Powder adhesives are used for tube winding.

10.2.3.3 *Health and safety*

Casein adhesives are non-flammable and have a good health and safety record. They do contain preservatives and may be mildly alkaline. Contact with skin and eyes should be avoided.

11 SYNTHETIC RESIN ADHESIVES

11.1 Thermosetting Resins

11.1.1 *Urea/Melamine Formaldehyde*

11.1.1.1 *General*

Urea/melamine formaldehyde is manufactured by the condensation reaction of urea and/or melamine with formaldehyde under controlled conditions, or the melamine may be added as part of the hardener. The usual technique is to stop the reaction by adjustment of *p*H and this is started and carried to completion as the adhesive sets by alteration of *p*H on addition of hardeners.

11.1.1.2 *Properties*

a) *Appearance and form*

A colourless or white liquid with solid content 45 to 70 percent but generally 60 percent to 70 percent, or a white spray-dried powder requiring mixing with water immediately prior to use.

b) *Viscosity*

Viscosity is generally medium to high for woodwork and low for paper impregnation.

c) *p*H *range*

The *p*H as supplied is in the range 7 to 8·5. The adhesive becomes acid to varying degrees after mixing with a hardener during setting.

d) *Storage conditions and shelf life*

Storage should be in cool conditions between 5°C to 20°C. It is essential that powders are kept dry and they should be stored in airtight containers. Shelf life is few months for liquids, but up to 1 year for some powders.

e) *Bonding characteristics*

Urea/melamine formaldehyde adhesives have little tack in the initial state and setting is by chemical action. Speed of set is therefore affected by types of product, choice of hardener and setting temperature. Full cure will not be obtained at temperatures below 10°C to 12°C.

When fully cured, resistance to oils, solvents, water, heat and cold is good. Resins made from melamine or including a proportion of melamine have better resistance to water, particularly hot water and to weather, than those made from urea alone, but not such good resistance as phenol formaldehyde resins. If surfaces to be bonded are rough and require gaps to be filled, it is essential that a gap filling grade is used.

11.1.1.3 *Use*

a) *Preparation*

Urea/melamine formaldehyde adhesives, except in the case of those used for wet strength papers, require the addition of a curing agent, and generally there is a choice available giving different pot lives and setting conditions which may be at room temperature or under heat. In the case of powders some may already contain a curing agent and only need mixing with water, others may require addition of a curing agent after such mixing. It is important that manufacturer's instructions regarding proportions and press time at specific temperatures are followed. Application may be by brush or roller spreader and it is important that equipment be cleared with water before the pot life has expired and the adhesive has set.

b) *End use*

These adhesives are used for wood lamination and assembly operations where good water resistance or short term weather resistance is required in the bond. Some grades may also be used as additives to starch adhesives to improve the water resistance, for example, in the manufacture of corrugated board or paper sacks requiring a degree of wet strength.

The lower viscosity and lower solids content materials are used for paper impregnation on acid papers to give improved wet strength and are then cured by heat alone.

c) *Health and safety*

Formaldehyde can cause a hazard by inhalation or skin contact. Where necessary, vapour should be controlled by specific extraction or good general ventilation. Skin contact should be avoided.

d) *Restrictions on use*

The adhesive bond when cured is acidic and contact with such a glue line could cause corrosion on materials not otherwise protected. There may also be a small concentration of formaldehyde vapour, a point to be noted if packaging anything sensitive to this substance.

11.1.2 *Phenol Formaldehyde*

11.1.2.1 *General*

Phenol formaldehyde adhesives are manufactured by the condensation reaction of phenols with formaldehyde under controlled conditions. The phenols generally used are phenol itself and resorcinol. The type of reaction may vary resulting in products that only require heat or *p*H alteration to cause setting or products that require addition of further reactants.

11.1.2.2 *Properties*

a) *Appearance and form*

Generally red-brown liquids which may be quite dark in colour, normally dispersed in water or water/methylated spirits mixture.

b) *Viscosity*

Viscosity may vary widely according to formulation.

c) *p*H *range*

Some types require very acid curing conditions, others very alkaline and some are near neutral.

d) *Storage conditions and shelf life*

Storage should be in cool conditions between 5°C to 25°C, and shelf life may vary with type from a few months to 1 year.

e) *Bonding characteristics*

Phenol formaldehyde adhesives have little tack in their initial state and setting is by chemical reaction. Speed of set is, therefore, considerably affected by type of product, choice of hardener and setting temperature. Full cure will not be attained at temperatures below 10°C to 12°C.

11.1.2.3 *Use*

a) *Preparation*

Some grades require heat only for curing, but most require the addition of a curing agent. It is important that the manufacturer's instructions regarding proportions and press time at specific temperatures are followed. Application may be by brush or roller coater, and it is important that equipment is cleaned with water or methylated spirit/water mixtures before the pot life has expired and the adhesive has set.

b) *End use*

These adhesives are used for wood lamination or assembly operations where the highest water and/or weather resistance is required in the bond.

c) *Health and safety*

Where methylated spirits are present, there, may be a flash point low enough to classify the product as flammable or highly flammable and therefore, appropriate precautions should be taken in storage and use.

Formaldehyde may cause a hazard by inhalation or skin contact. Where necessary, vapour should be controlled by specific extraction or good general ventilation. Skin contact should be avoided.

d) *Restriction on use*

The adhesive bond when cured may be highly acidic or highly alkaline and contact with such a glue line could cause corrosion on materials not otherwise protected. There may also be a small concentration of formaldehyde vapour, a point to be noted if packaging sensitive to this substance.

11.1.3 *Polyurethane Adhesives*

11.1.3.1 *General*

The types of polyurethane adhesives used in packaging are as follows.

a) Resins with active groups which may react with isocyanates groups: provided by a curing agent which is added before use;

b) Resins with reactive isocyanate groups which react with moisture in the atmosphere or on the substrate; no curing agent is used with this type.

Both these types are dissolved in organic solvents, which are generally highly flammable.

11.1.3.2 *Properties*

a) *Appearance and form*

Polyurethane adhesives are colourless or straw coloured liquids.

b) *Viscosity*

For machine application low viscosity (500 mPa-s to 5 000 mPa-s) is required. Solids content is normally 25 percent to 45 percent.

c) *Storage conditions and shelf life*

Storage should be in cool conditions between 5°C to 25°C. Shelf life is typically 6 months, bit for resins described in **11.1.3.1**(b) and curing agents, it is essential that moisture be excluded. Containers should be kept tightly closed and full containers should be used quickly. Moisture contamination can lead to the development of pressure within the container.

d) *Bonding characteristics*

Normally the adhesive is machine applied to one surface which is force dried. After drying, hot nipping is used and at this point the 'green' (initial) strength is sufficient to hold materials together. Full curing can be achieved by storing at ambient temperature.

The adhesives may be formulated to provide excellent resistance to heat, water, oils and grease. The moisture curing type have lower resistance but are still satisfactory for many purposes.

11.1.3.3 *Use*

a) *Preparation*

Polyurethane adhesives may be supplied ready for use or for dilution with dry organic solvents immediately prior to use. In the case of a two-part adhesive, mixing of adhesive and catalyst in accurate amounts should first be carried out. If required, viscosity is adjusted by solvent addition and it may be necessary to make further adjustments during use.

b) *End use*

Polyurethane adhesives are used to laminate plastics films for flexible packaging requirements. Generally, at heat-seal film, for example, polyethylene is on the inside and is laminated to another film to give improved properties, such as strength, barrier properties and water resistance.

The laminates produced in this way are used for a variety of foods. The highest performance is required for such products as boil-in the bag foods and for these requirements a two-part adhesive would be necessary.

c) *Health and safety*

Polyisocyanates are usually used to formulate these adhesives which have a low residual monomer content and so a vapour hazard does not normally arise unless curing is carried out by heat. Precautions may need to be taken if the adhesive is applied by spray.

d) *Special application technique*

A recent development with polyurethane adhesives is to supply them as high viscosity liquids or gels, which are applied on special application equipment at 80°C to 100°C. Such components contain no solvents but need accurately controlled application and at present tend to have a low initial bonding grab.

11.1.4 *Epoxy Adhesives*

11.1.4.1 *General*

Epoxy adhesives are synthetic resins containing epoxy groups available for cross-linking with suitable hardeners. These are available in liquids, pastes or solids in one-part (hot cure) or two-part (cold or warm cure) systems. Epoxy adhesives find application for bonding difficult surfaces.

11.1.4.2 *Properties*

a) *Viscosity*

For liquid type epoxy adhesives, the viscosity range is usually 3 000 to 10 000 mPa-s and for paste type adhesives it is up to 1 000 000 mPa-s

b) *Bonding characteristics*

Epoxy resins bond to most substrates, exceptions being non-polar surfaces like certain thermoplastics (for example, polyethylene, polypropylene) which require special pre-treatments to render them polar.

Most room temperature curing adhesives are suitable for joints which are subjected to a maximum operating temperature of 60°C in use. Specially formulated adhesives may be used in joints subjected to an operating temperature of 120°C. Hot-setting adhesives can be used for joints *subjected to temperatures up to 160°C.* Bond strengths in excess of 10 N/mm^2 are normally obtained on most metal surfaces.

11.1.4.3 *Use*

a) *Preparation and method of application*

Epoxy-resin based adhesives are of the thermosetting type. They set by cross-linking with a curing agent or a hardener. Hardeners are added in a prescribed ratio to the resin just before application in two-component systems. Latent hardeners may be pre-mixed with the resin to give one-component systems. Two-component systems cure at room temperature or at elevated temperature, depending on the hardener used. One-component systems are invariably cured at elevated temperature. Joints cured at elevated temperature are resistant to higher temperature than those cured at room temperature.

Two types of epoxy adhesives, liquid and paste are used in packaging. For certain applications where very thin glue lines are required, a liquid adhesive is preferred. Liquid adhesives can be applied by brush or by special dispensing machines. Other applications involving thicker glue lines require a filled, paste type adhesive usually thixotropic in nature, which may be applied by spatula.

Epoxy resin based adhesives may be modified with a wide variety of fillers such as finely divided chalk, talc, graphite or other minerals, metal powders or glass fibre to obtain certain desired properties. Filled adhesives are normally used when the gap between the adherends is wider than 200 µm. Metal powders improve thermal conductivity. Silver, copper or graphite powder impart good electrical conductivity to the adhesive.

11.1.4.4 *End use*

Epoxy resin based adhesives, because of their very high adhesive strength, find application in bonding metals, glass, ceramics, concrete, wood and certain types of plastics. They are, therefore, widely employed in aircraft construction, automobile fabrication, glued rail joints, electronic assemblies and in other engineering industries, besides being used for sealing metal containers and repairs of different kinds.

11.1.4.5 *Health and safety*

Most cured epoxy adhesives are safe for use in contact with foodstuffs. It is, however, strongly recommended to check with the manufacturer in respect of compliance with local food and drug regulations.

In the uncured state, many resins and hardeners on contact with the skin, cause an irritation *known as dermatitis. In using them, therefore,* contact with the skin should be avoided as far as possible. The use of barrier creams and cleansing creams minimizes risks.

No volatiles are normally produced on curing. However, on curing at elevated temperatures, some curing agents vaporize to a small extent and hence it is advisable to provide curing.

Manufacturers may be contacted for detailed health and safety instructions.

11.2 Thermoplastic Resins Applied in Emulsion or Solution Form

11.2.1 *Polyvinyl-Acetate (PVAC) and Copolymers*

11.2.1.1 *General*

Polyvinyl-acetate adhesives are manufactured by the homopolymerization of vinyl-acetate monomers or copolymerization with other monomers such as ethylene or butyl maleate.

11.2.1.2 *Properties*

a) *Appearance and form*

Thermoplastic resin emulsion adhesives are available in liquid form only. They are normally white in colour, unless dyed for a specific application, and dry to a film which can vary from clear to translucent depending on the formulation. The flexibility of the dried form is also variable. Solutions of these resins in organic solvents are available and are normally clear.

b) *Viscosity*

The emulsion adhesives may be formulated to a range of viscosities from water thin to a pasty consistency. The solids content is typically between 40 percent and 65 percent.

c) *pH range*

The emulsion forms are neutral to slightly acidic in the range 7 to 4.

d) *Storage conditions and shelf life*

Ideal storage conditions are between 5°C and 20°C. In the case of emulsions freezing should be avoided as the adhesives are irreparably damaged if this occurs. To prevent contamination and evaporation, the containers should be kept closed when not in use.

Shelf life is typically up to 6 months.

e) *Bonding characteristics*

The formulation of any particular adhesive determines its adhesion versatility, speed and tack. Because the setting process is due to water or solvent loss from the system, at least one of the surfaces to be bonded has to be porous, otherwise drying cannot take place.

Emulsion adhesives are generally faster setting than starches and dextrins but not as fast as hot melts. The tack can vary from very low to pressure sensitive.

These adhesives may be made to have good water resistance or water redispersability. Due to the thermoplastic nature of the resins, softening may occur at elevated temperatures. Cross-linked emulsions have much improved heat and solvent resistance.

11.2.1.3 *Use*

a) *Preparation and method of application*

The adhesives are supplied in ready for use form. On occasion the adhesive may be diluted (with solvent or water) but the supplier should be consulted before this is done. Typical application is by wheel, roller or stencil applicator, spray, low pressure extrusion or ball pen type applicator.

b) *End use*

Emulsion adhesives are found in all areas of packaging where paper and board are being bonded. Recent developments in emulsion adhesives have seen their introduction into such areas as bottle labelling where plastic bottles are being labelled, and also in wet process lamination. Typical uses include case and carton forming and sealing, bag making and sealing, board lamination and tube winding. They may be used as re-moistenable adhesives and for wood gluing. Solvent solution adhesives are used as heat-seal adhesives by pre-coating papers.

c) *Health and safety*

These adhesives are generally of low hazard and should be used with normal hygiene and good housekeeping methods. In some cases adhesives may be identified as containing small amounts of flammable or non-flammable solvents and information should be sought from the manufacturer regarding flammability and toxic hazards.

11.2.2 *Other Vinyl Resins*

11.2.2.1 *General*

By far the greatest usage of vinyl polymer resin adhesives is in polyvinyl acetate and copolymers (*see* **11.2.1**). However, a variety of other vinyl polymers are used in much smaller quantities, including polyvinyl propionate and copolymers, polyvinyl alkyl ethers, polyvinylidene chloride and polyvinyl chloride. Due to the wide variety of types, information given in **11.2.2.2** and **11.2.2.3** summarizes only the main characteristics.

11.2.2.2 *Properties*

a) *Appearance and form*

Vinyl polymer resins are supplied as solutions or emulsions. Solutions in organic solvents or water are generally colourless to pale straw liquids. Emulsion adhesives are white when wet, drying to give translucent films.

b) *Viscosity*

The majority of the adhesives are of low viscosity (50 mPa-s to 500 mPa-s) for some applications adhesives of higher viscosity up to 10 000 mPa-s may be used. The solid content varies from 20 percent to 45 percent.

c) *Storage conditions and shelf life*

Storage should be between 5°C to 25°C; where flammable solvents are used, storage should be in accordance with current regulations. Shelf life may vary with different types but in the majority of cases would be between 6 to 12 months.

In the case of emulsions, irreparable damage is caused by freezing.

d) *Bonding characteristics*

If used as a pre-coating, forced drying is normally used. When used as a wet stick adhesive, the application technique will depend on the end use. The tack and drying period will depend on the particular formulation.

Most vinyl polymer resins have good resistance to moisture, but the extent of this and other resistances varies widely with formulation. All are thermoplastic, so resistance to heat will be limited.

11.2.2.3 *Use*

a) *Preparation and method of application*

Vinyl polymer resin adhesives are generally supplied ready for use but if used for roller coating the solvent grades may require some dilution with appropriate thinners and viscosity may need further adjustment during running.

d) *End use*

These adhesives are occasionally used to provide wet stick adhesion to difficult surfaces, for example, plastics bottle labelling, but the greatest use is in the formulation of heat seal or pressure sensitive adhesives.

c) *Health and safety*

The main requirement for care would be to prevent inhalation of solvent fumes and residual monomers. It is essential to take precautions against ignition where flammable solvents are present.

Coating operations may lead to static charge generation and it is essential that equipment and processes are electrically safe.

11.2.3 *Polyvinyl Alcohol (PVAL)*

11.2.3.1 *Manufacture*

Polyvinyl alcohol adhesives are manufactured by the total or partial hydrolysis of polyvinyl acetate under controlled conditions to provide different grades.

11.2.3.2 *Properties*

a) *Appearance and form*

Polyvinyl alcohol is a solid which has to be dissolved in water for use as an adhesive. It is available in powder or prepared solution form. The latter form may be light coloured or clear or alternatively compounded with fillers.

b) *Viscosity*

The adhesives as used as fluid but vary widely in viscosity. The solid content varies from 10 percent to 20 percent for unfilled and up to 40 percent for filled grades.

e) *p*H *range*

The *p*H ranges from slightly acidic to neutral (6 to 7) but certain grades may be more acidic.

d) *Storage conditions and shelf life*

Ideal storage conditions for solutions in closed containers are between 5°C and 25°C.

The powder form should be stored in dry conditions and containers should be kept closed when not in use. Shelf life for the liquid adhesive is typically up to 6 months.

e) *Bonding characteristics*

Excellent wet tack may be obtained provided coating is accurately controlled. Since the setting process is due to water loss from the system, at least one of the surfaces to be bonded has to be porous otherwise drying may not take place.

Adhesion is good in porous materials such as paper and board but generally poor with the synthetic non-porous surfaces. However, good adhesion may be obtained between porous substances and non-coated glass.

Water resistance of polyvinyl alcohol adhesives is dependent on formulation. Grades are available with good water resistance if required, while other grades are re-moistenable. Resistance to oils is generally good.

11.2.3.3 *Use*

a) *Preparation and method of application*

Some powder forms are soluble in cold water while others require heating in water to 80°C to 90°C to obtain satisfactory solutions. The powder should be added to cold water with good stirring. Application is normally by wheel or roller.

b) *End use*

These adhesives are used typically for paper and board lamination and as re-moistenable adhesives for tapes, labels, etc.

c) *Health and safety*

Polyvinyl alcohol adhesives are generally of low hazard and should be used with normal hygiene and good housekeeping methods.

11.2.4 *Acrylic Resins*

11.2.4.1 *General*

Acrylic resin adhesives, manufactured by the copolymerization or homopolymerization of acrylic monomers are used in packaging as pressure-sensitive adhesives and for some heat seal applications in flexible film packaging.

11.2.4.2 *Properties*

a) *Appearance and form*

Acrylic homopolymers and copolymers are supplied in emulsion (water borne), solution (solvent borne) or solid (for application by hot melt techniques). The emulsions are white in colour when wet and the solutions transparent to translucent. Solid forms are supplied as translucent blocks with a tacky surface. All three types can be used to prepare adhesives offered in pre-cut tape form, protected by release papers.

b) *Viscosity*

The viscosity and solids content can vary over a wide range according to application. Tacky solid or 'pressure-sensitive hot melts' require specialized equipment and the viscosity at the temperature of application (above 160°C to 200°C) shall be 12 Pa-s to 60 Pa-s.

c) *p*H *range*

Acrylic homopolymer and copolymer emulsions usually have a *p*H in the range

5·5 to 9·5. The solvent borne and solid types are non-aqueous and aqueous extracts and are close to neutrality.

d) *Storage conditions and shelf life*

Shelf life of the emulsion is usually 12 months at 5°C to 25°C. They shall be protected from frost.

In the original unopened container within a temperature range of 5°C to 30°C, the majority of compounds in solution form will have shelf life of 6 months.

With hot melts and preformed tapes in the original unopened container within a temperature range of 5°C to 30°C, the majority of compounds will have shelf life of 12 months.

e) *Bonding characteristics*

Pressure-sensitive adhesives produce a permanently tacky film to which a second adherend readily adheres after the brief application of suitable pressure.

Adhesives may be prepared with characteristics varying from low peel strength to bonds that are regarded as permanent.

The liquid grades and hot melts are coated on to the substrates, the solvent or water evaporated and the adhesive film used immediately or in their preformed tape form protected with a release paper.

Most adhesives of this type have good water resistance; some types may bond successfully under external weather conditions. Pressure-sensitive adhesive bonds for exposure to sub-zero conditions or temperatures up to 70°C may also be prepared.

Acrylic resin adhesives have no resistance to permanent contact with solvents but considerable oil and plasticizer resistance is attainable.

11.2.4.3 *Use*

a) *Preparation and method of application*

The liquid adhesives are applied by techniques varying from automatic high speed plant to manual brush application. High speed wet coating by roller, screen printing, dipping, etc, will produce adhesive films directly on to the article to be bonded or on to release coated paper for subsequent transfer.

Hot melt pressure-sensitive adhesives are applied in a similar manner to hot melt adhesives (*see* **12.2**) with the use of release paper as required.

b) *End use*

These adhesives are used for bonding plastics films to themselves and to board, ard in the manufacture of pressure-sensitive (self-adhesive) tapes and labels.

c) *Health and safety*

Where solvents are used, these are usually highly flammable types subject to regulations covering storage, use and disposal of waste material. Coating operations can lead to static charge generation and equipment and processes have to be electrically safe.

Acrylic-based hot melts and waxes do not liberate solvent and under normal conditions of use do not present a flammable hazard but severe overheating could cause a fire. At their application temperatures, severe burns would be caused on contact with the body and the face and bare skin has to be protected.

Inhalation of fumes should be avoided and adequate ventilation or extraction provided.

Water-borne adhesives are of low hazard to the user and should be used with normal hygiene and good housekeeping methods.

12 THERMOPLASTIC ADHESIVES SUPPLIED IN SOLID FORM (HOT MELTS AND WAXES)

12.1 General

Thermoplastic polymers and their mixtures with resins, waxes and oils are synthesized and formulated as hot melt adhesives for bonding, laminating and sealing. Base polymers with significant use are ethylene copolymers, polyethylene, polypropylene, polyesters, polyamides and polyvinyl acetates. Specific properties are developed for formulations, for example, petroleum waxes and oils are viscosity modifiers, resins are tack and adhesion promoters.

Since hot melt adhesives set by rapid cooling, high production speeds may be obtained with most porous and non-porous packaging materials.

Waxes are used either without or with minor polymer modifications, mainly for coating and heat seals of limited durability. Those derived from petroleum (paraffin and microcrystalline) are the largest volume types used, Polyethylene and polypropylene are sources of wax like polymers used extensively in formulating.

12.2 Properties

12.2.1 *Appearance and Form*

Different grades of hot melt adhesives add waxes may be made available in beed, chip, slug, block or film forms.

12.2.2 *Viscosity*

Hot melts and waxes are thermoplastic and are heated to the state of mobile liquids. There is no standard viscosity for these products, as each type of application requires its own temperature viscosity relationship. As a general guide, operating temperatures at the point of application will be 80°C to 100°C for waxes and above 140°C for hot melts, the viscosity will be in the range 300 mPa-s to 2 000 mPa-s.

12.2.3 *Storage Conditions and Shelf Life*

In the original unopened container, in dry conditions within the temperature range of 5°C to 25°C, the majority of compounds will have a shelf life of 12 months. Manufacturers should indicate exceptions to this.

12.2.4 *Bonding Characteristics*

Hot melts and waxes develop adhesive strength by solidifying between surfaces which have been combined whilst the hot melt or wax is liquid enough for wetting of both surfaces. Tack may be varied to include adhesives which have permanent 'pressure-sensitive' tack at room temperature and those which are not tacky. Setting times are usually much shorter for hot melt adhesives than for aqueous or solvent borne adhesives since there are no volatile constituents to evaporate.

Waxes are used for improving the resistance to water of cellulose and other natural fibre packaging materials and reducing the water vapour permeability of board and films.

Most hot melts and waxes have a lower resistance to heat than emulsion, dextrine or starch adhesives. The strength of the bond will also vary as the temperature falls but suitable hot melt formulations are available for use under deep freeze conditions (down to —40°C).

Where extremes of temperature are likely to be encountered, the manufacturer's advice should be sought.

Most hot melts and waxes have no resistance to permanent contact with oils, solvent or their vapours.

12.3 Use

12.3.1 *Preparation and Method of Application*

Equipment of varying complexity have been developed to apply continuous films, lines or discrete spots from appliances ranging from small scale manual operation to high speed automatic plant. The common mechanical features are:

a) A heated pot carrying a reservoir of molten adhesive;

b) A means of applying the heated adhesive in the required pattern by wheel, roller, nozzle or dauber.

Manufacturers shall be consulted as to the correct procedures to be adopted for the use of their adhesives, in conjunction with the particular applicator.

12.3.2 *End Use*

Hot melts are fast setting, resulting in high production speeds being attainable, coupled with short compression times enabling shorter machine lengths to be achieved. They have the advantage that they can be used not only for porous materials but also where two non-porous surfaces are to be bonded.

Hot melts are used in most areas of packaging, such as case and carton forming and sealing, title winding, bag and sack making and sealing, tray construction and labelling. Hot melts are also used as palletizing adhesives to improve the cohesion of a pallet load.

Hot melt formulations are also available for pressure sensitive applications, for example, labels and tapes. Waxes are used in heat seal coating for paper and board and for board lamination.

12.3.3 *Health and Safety*

Manufacturers should be consulted about the safe use of their products. As a class, hot melts and waxes under normal conditions of use do not present a flammable hazard but severe overheating could cause a fire. At their application temperatures, severe burns would be caused on contact with the body and the face and bare skin has to be protected.

Inhalation of fumes should be avoided and adequate ventilation or extraction provided.

13 VEGETABLE ADHESIVES

13.1 Adhesives Based on Flour and Unmodified Starches

13.1.1 *Properties*

13.1.1.1 *General*

a) Vegetable adhesives based on flour and unmodified starches are available in either liquid or powder form. The powder form is usually soluble in either hot or cold water.

They are usually off-white or yellowish in colour.

13.1.1.2 *Viscosity*

These adhesives are of a pasty consistency which can vary from very thick to a soft buttery paste. The solids content varies from 20 percent to 35 percent.

13.1.1.3 *pH range*

The *p*H of these adhesives typically ranges from acid to slightly alkaline (2 to 8).

13.1.1.4 *Storage conditions and shelf life*

When supplied in the liquid form, vegetable adhesives thicken up (set back) on ageing.

Temperature affects the speed at which this process takes place, cold accelerates the setting back process and warmth retards it. Ideal storage conditions are between 15°C and 20°C and the shelf life is typically between 3 months to 6 months.

Powders should be stored in cool, dry conditions and the liquids prepared from them should ideally be used within 24 hours.

13.1.1.5 *Bonding characteristics*

These adhesives have low tack and slow drying speed. The slow drying is attributed to the normally low solids contents, combind with high viscosity.

The water resistance of these vegetable adhesives is poor though the resistance to temperature extremes is very good. Solvent resistance is not normally a requirement of starch-based adhesives but it would be expected to be reasonable.

13.1.2 *Use*

13.1.2.1 *Preparation and method of application*

These adhesives are available in either liquid (ready-for-use) or powder form. The powder should be dissolved in water, in some cases hot water may be necessary. Unmodified starches may require cooking in water before use to achieve satisfactory solution and viscosity. Liquids prepared from powder may be subject to microbiological attack and should be protected by the use of a preservative, if they are to be kept for more than 24 hours. Application is by wheel, roller or stencil.

13.1.2.2 *End use*

Typical uses are labelling by hand and in the manufacture of paper bags.

13.1.2.3 *Health and safety*

These adhesives are generally of low hazard and should be used with normal hygiene and good housekeeping methods.

13.1.2.4 *Patterns of use*

The use of unmodified starches has declined, being replaced by improved modified starches.

13.2 Chemically Modified Starches

13.2.1 *Properties*

13.2.1.1 *Appearance and form*

Modified starch adhesives are available in liquid or powder form. Generally, these adhesives are similar to flour adhesives but they may be of darker colour.

13.2.1.2 *Viscosity*

Modified starch adhesives vary from rubbery highly cohesive jelly gums to fluid tacky products. The solids content ranges from 15 percent to 50 percent.

13.2.1.3 *p*H *range*

The *p*H of these adhesives ranges from slightly acid to alkaline (6 to 11).

13.2.1.4 *Storage conditions*

Powders should be stored in cool dry conditions and the liquids prepared from them should ideally be used within 24 hours. Liquid forms of modified starches are more viscosity stable than unmodified starches. Ideal storage conditions are between 5°C and 20°C.

13.2.1.5 *Bonding characteristics*

Generally, these adhesives have higher tack and faster setting than unmodified starches 'jelly gums' will stick to coated glass and some plastics.

The water resistance is better than unmodified starches and the resistance to temperature extremes is good. Solvent resistance is not generally a requirement.

13.2.2 *Use*

a) *Preparation and method of application*

The powder form should be dissolved in water according to the manufacturer's instructions. 'Jelly gum's come ready for use and are normally run on automatic or semi-automatic machines. The application is typically via a roller and adhesive transfer system. 'Jelly gums' are used solely for bottle labelling.

b) *End use*

The fluid modified starches are used for foil to paper lamination and the manufacture of corrugated fibreboard and paper sacks. Adhesive application here is normally from a series of rollers.

c) *Health and safety*

These adhesives are generally of low hazard and should be used with normal hygiene and good housekeeping methods.

13.3 Dextrin

13.3.1 *Properties*

13.3.1.1 *Appearance and form*

Ready for use dextrin glues (borated alkaline dextrins) have low solids content and vary from thixotropic pasty adhesives to watery fluid ones. Dextrin gums have higher solids content and are generally higher in viscosity.

Dextrin glues are available in powder form for dissolving in water but are rarely used in this manner.

13.3.1.2 *Viscosity*

These adhesives range from watery fluids to thick pastes.

Typical solids contents are 30 to 50 percent for the borated dextrins and 50 to 60 percent for the dextrin gums.

13.3.1.3 *p*H *range*

Dextrin glues are alkaline (*p*H range 8 to 11) whereas dextrin gums are acidic (*p*H range 2 to 4).

13.3.1.4 *Storage conditions and shelf life*

If kept under good storage conditions (between 5°C to 25°C), dextrin-based adhesives are normally viscosity stable. Some borated dextrin products may be filled with clay which tends to settle when in storage; however, they may be made usable with stirring. Shelf life is 3 months to 6 months.

13.3.1.5 *Bonding characteristics*

Depending on formulation, the tack of these products ranges from low to very high. Dextrins are faster setting than starch adhesives and hence are preferable in application where speed of drying is important.

13.3.1.6 *Water resistance*

Water resistance is poor.

13.3.2 *Use*

13.3.2.1 *Preparation and method of application*

Dextrin adhesives are normally supplied ready for use.

The low viscosity products can be applied by low pressure extrusion as well as by standard wheel, roller or stencil applicator. The higher viscosity products are unsuitable for extrusion.

13.3.2.2 *End use*

Dextrin glues are used in a wide range of packaging applications involving paper and board, such as case and carton sealing, tube winding, board laminating and wrap around can labelling.

Dextrin gums are typically used for bottle labelling uncoated glass only and packet sealing and are also formulated as remoistenable adhesives for envelope manufacture.

13.3.2.3 *Health and safety*

Dextrin adhesives are generally of low hazard and should be used with normal hygiene and good housekeeping methods.

13.4 Cellulose Derivatives

13.4.1 *Water-based*

13.4.1.1 *General*

These adhesives are based on water soluble ethers and sodium alkoxy salts derived from cellulose.

13.4.1.2 *Properties*

a) *Appearance and form*

These adhesives are available in powder form for dissolving in water but are also supplied as ready for use liquids which are typically clear or translucent.

b) *Viscosity*

Depending on formulation and end use the viscosity may vary from 100 mPa-s to 100 000 mPa-s.

Solids contents vary over a wide range between 5 to 70 percent.

c) *p*H *range*

The *p*H of these adhesives ranges from slightly acidic to neutral (6 to 7).

d) *Storage conditions and shelf life*

Ideal storage conditions are between 5°C and 25°C. To prevent contamination and evaporation the containers should be kept closed when not in use.

Shelf life is typically 3 months.

e) *Bonding characteristics*

These adhesives are formulated to give 'dry releases' properties. They are very low tack products giving almost no adhesion when dry.

Most of these products are repulpable.

13.4.1.3 *Use*

a) *Preparation and method of application*

Powders require to be dissolved in water. The resulting solutions and those supplied ready for use are applied by spray, roller techniques or low pressure extruders. Some require heating to approximately 40°C for use.

b) *End use*

These adhesives are used as 'pick up' and 'tail-tie' for the paper towel and tissue industries where repulpability is a requirement.

c) *Health and safety*

Cellulose adhesives are generally of low hazard and should be used with normal hygiene and good housekeeping methods.

13.4.2 *Spirit Soluble*

13.4.2.1 *General*

Cellulose nitrate is used as the basis of pre-coating adhesives but such products are generally highly compounded including the addition of other resins, polymers and/or plasticizers.

13.4.2.2 *Properties*

a) *Appearance and form*

Spirit soluble cellulose adhesives are supplied as colourless to straw of light-brown liquids.

b) *Viscosity*

Viscosity may be varied for different purposes. For roller coating a viscosity of 50 mPa-s to 200 mPa-s is normally used. Solids content is normally in the range of 20 percent to 45 percent.

c) *Storage conditions and shelf life*

Storage should be in cool conditions between 5°C and 25°C and, since materials are highly flammable, should be according to current regulations. In unopened containers shelf life would be expected to be 12 months.

d) *Bonding characteristics*

These adhesives are generally used by precoating boards and drying for later heat sealing at temperatures normally in the 140°C to 180°C range.

They have good resistance to moisture but being thermoplastic, resistance to heat is limited. Resistance to solvents is poor.

13.4.2.3 *Use*

a) *Preparation and method of application*

Spirit soluble cellulose adhesives may be supplied ready for use or to be thinned down with solvents as required. The amount of thinning will vary the solid weight deposited and some porous boards will require higher viscosities to prevent excessive penetration of adhesive into the board surface. When being used on printed boards, tests should be made to ensure that the adhesion is being obtained between specific inks and the coating.

b) *End use*

These adhesives are used as blister or skin pack seal lacquers.

c) *Health and safety*

The main requirement for care would be to prevent inhalation of solvent fumes and residual monomers. It is essential to take precautions against ignition where flammable solvents are present.

Coating operations may lead to static charge generation and it is essential that equipment and processes are electrically safe.

13.5 Natural Resins

13.5.1 *General*

Resins and its derivatives are the main materials used in the adhesive bases in natural resins but they are also used as modifiers and extenders for other thermoplastic resin adhesives.

13.5.2 *Properties*

13.5.2.1 *Appearance and form*

Different grades of natural resin adhesives can be made available in block or bead forms.

13.5.2.2 *Viscosity*

Natural resin adhesives, as with hot melts, are thermoplastic and are heated to the state of mobile liquids. Application temperatures are typically 100°C and 120°C and the viscosity will be in the range 200 mPa-s to 1 000 mPa-s.

13.5.2.3 *Storage conditions and shelf life*

Natural resin adhesives require similar conditions to hot melts but some products may present problems of migration of ingredients after storage periods of greater than 6 months.

13.5.2.4 *Bonding characteristics*

It is the molten tack of the adhesive which is its main feature. Natural resin adhesives are exclusively used in labelling as can pick-up adhesives and do not actually bond the label to the can when solidified. The adhesive is only required to have sufficient tack to extract a label from the stack when the can rolls over the label.

Bonds tend to be brittle when at room temperature.

13.5.3 *Use*

13.5.3.1 *Preparation and method of application*

Natural resin adhesives are typically applied by a wheel in a glue pot, heated to the required application temperature.

13.5.3.2 *End use*

These adhesives are used as pick-up adhesives for can and jar lebelling applications.

13.5.3.3 *Health and safety*

Manufacturers should be contacted about the safe use of their products. Natural resin adhesives under normal conditions of use do not present a flammable hazard but overheating could cause a fire. At their application temperatures severe burns would be caused on contact and the face and skin should be protected.

Inhalation of fumes should be avoided and adequate ventilation or extraction provided.

13.6 Natural Gums

13.6.1 *General*

A range of naturally occuring water-soluble gums arabic is the principal material still used as an adhesive base.

13.6.2 *Properties*

13.6.2.1 *Appearance and form*

Natural gum adhesives are normally fluid aqueous solutions varying from yellow/white to amber in colour.

13.6.2.2 *Storage conditions and shelf life*

These adhesives are very stable and should be stored between 5°C and 25°C.

13.6.2.3 *Bonding characteristic*

Bonding is achieved by the evaporation of water. The bonds have poor resistance to water.

13.6.3 *Use*

13.6.3.1 *Preparation and method of use*

Natural gum adhesives are normally supplied in solution form ready for use.

13.6.3.2 *End use*

These adhesives are used mainly for the production of water remoistenable tapes and labels.

13.6.3.3 *Health and safety*

These adhesives are of low hazard and should be used with normal hygiene and good housekeeping practice.

14 MISCELLANEOUS ADHESIVE TYPES

14.1 Emulsion Starch

Emulsion starches are usually mixtures of polyvinyl acetate homopolymer or copolymer emulsions and starch, produced to enhance the adhesion properties of the basic starch pastes. Starch adhesives do not give adhesion to difficult surfaces while the emulsion does. The pasty consistency of the paste and the adhesion characteristics of the emulsion combine to give the properties required for particular applications.

In packaging, by far the major use is for can labelling where a varnished overlap is encountered.

14.2 Casein Latex

Casein is added to latex adhesives in order to further improve the wet tack or the adhesion characteristics to certain surfaces.

Casein latex adhesives are used for plastics bottle labelling, foil to board lamination and some self-seal applications.

14.3 Vinyl Dextrin

Vinyl dextrin adhesives are polyvinyl acetate emulsions containing dextrin. The largest use for these adhesive is for envelope manufacture. Remoistenable dextrin adhesives give the good remoistenability and gloss on the envelope front flap but do not give good 'lay flat' properties. The vinyl dextrin gives good 'lay flat' as well. This is essential for envelopes which are to be put through automatic filling machines as a curled flap can easily cause machine stoppages.

ANNEX A

(*Clause* 2.1)

INDIAN STANDARDS RELATING TO ADHESIVES WHICH MAY BE OF RELEVANCE TO PACKAGING

IS No.	*Title*
425 : 1953	Shellac adhesives for steam flange joints
848 : 1974	Synthetic resin adhesives for plywood (phenolic and aminoplastic) (*first revision*)
849 : 1957	Cold setting casein glue for wood
850 : 1957	Natural sour (lactic) for glue manufacture
851 : 1978	Synthetic resin adhesives for construction work (non-structural) in wood (*first revision*)
852 : 1969	Animal glue for general wood-working purposes (*first revision*)
1508 : 1972	Extenders for use in synthetic resin adhesives (urea-formaldehyde) for plywood (*first revision*)
2257 : 1989	Paper adhesives, liquid gum and office-paste type (*third revision*)
2880 : 1986	Pressure sensitive adhesive cellulose tapes (*third revision*)
3116 : 1965	Sealing compound for lead-acid batteries

IS No.	*Title*
3434 : 1984	Glossary of terms for adhesives and pressure sensitive adhesive tapes (*first revision*)
3447 : 1965	Shellac jointing for gasket compounds
3676 : 1986	Pressure sensitive adhesive PVC tapes (*second revision*)
3687 : 1987	Pressure sensitive adhesive cloth tapes (*second revision*)
3988 : 1981	Guar gum (*first revision*)
4185 : 1967	Gummed paper tapes
4835 : 1979	Polyvinyl acetate dispersion-based adhesives for wood (*first revision*)
5025 : 1985	Gum karaya (*second revision*)
6367 : 1971	Dextrin for adhesive industry
7393 : 1974	Adhesive, bitumen emulsion
7437 : 1974	Methods of sampling and test for vegetable adhesives
8402 : 1988	Methods of sampling and test for pressure sensitive adhesive tapes
9188 : 1979	Performance requirements for adhesives for structural laminated wood products for use under exterior exposure conditions
11022 : 1984	Methods of sampling and test for glues (bone, skin/fleshings and fish glues)
11310 : 1985	Babul gum
11856 : 1986	Adhesive caulking compound, bitumen based

ANNEX B

(*Clause* 5.2)

GUIDE TO PACKAGING END USES AND SUITABLE TYPES OF ADHESIVE

B-1 CONVERTING

B-1.1 Suitable adhesives are shown for the following end uses.

B-1.1.1 *Lamination*

a) Corrugating	Starch and modified starch synthetic emulsions
b) Film (plastics)	Aerylic resins Polyurethanes Synthetic emulsions
c) Foils	Casein latex Synthetic emulsions
d) Paper and board	Bitumen Dextrin Microcrystalline waxes Synthetic emulsion (PVAC)
e) Tube winding	Animal glue Casein Dextrin Hot melts Sodium silicate Synthetic emulsions

B-1.1.2 *Package manufacture*

a) Carton manufacture	Hot melts Synthetic emulsions
b) Case manufacture	Hot melts Synthetic emulsions
c) Envelopes	Dextrin Hot melts Natural latex Synthetic emulsions Vinyl dextrin
d) Labels and tapes:	
i) Pressure-sensitive	Acrylic resins Hot melts
ii) Remoistenable	Animal glue Dextrin
e) Paper sacks and bags	Hot melts Starch and modified starch Synthetic emulsions Urea/melamine formaldehyde
f) Plastics sacks and bags	Hot melts Synthetic emulsions

B-2 PACKAGING OPERATIONS

B-2.1 Suitable adhesives are shown for the following end uses.

B-2.1.1 *Container and Packet Sealing*

a) Carton sealing	Dextrin Hot melts Natural latex Synthetic emulsions
b) Case sealing	Dextrin Hot melts Synthetic emulsions

c) Tray erection	Hot melts Synthetic emulsions Natural latex (for self-seal)
d) Miscellaneous:	
i) Heat seal	Cellulose derivatives Hot melts Synthetic emulsions Vinyl resins
ii) Wooden cases	Animal glue Phenol formaldehyde Synthetic emulsions Urea/melamine formaldehyde
e) Metal containers	Epoxy resins (especially for seams)

B-2.1.2 *Labelling*

a) Glass containers	Casein Dextrin gum Hot melts Modified starch Natural resins Synthetic emulsions Vinyl dextrin
b) Metal cans	Dextrin Emulsion starch Hot melts Natural resins Synthetic emulsions
c) Plastics containers	Casein latex Hot melts Modified starch Natural latex Synthetic emulsions
d) Palletizing	Hot melts Synthetic emulsions

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